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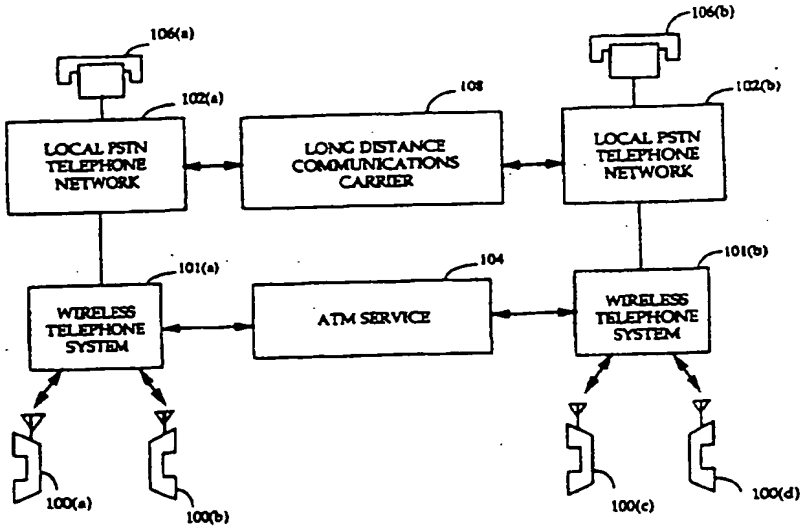
(54) Title: METHOD AND SYSTEM FOR PROCESSING TELEPHONE CALLS INVOLVING TWO DIGITAL WIRELESS SUBSCRIBER UNITS THAT AVOIDS DOUBLE VOCODING

(57) Abstract

A method and system for processing telephone calls within a digital wireless telephone system (101) is described. During the initiation of a telephone call from a wireless subscriber unit (100) it is determined whether the receiving subscriber unit (100, 106) is also part of a digital wireless telephone system that has compatible vocoding capability. If so, vocoded data from the digital wireless telephone system (101) is converted into tones that are introduced into a wire based telephone system for routing to the appropriate receiving digital wireless telephone system. When these tones are received by the receiving digital wireless telephone system (101) the vocoded data is regenerated based on the tones and then transmitted to the receiving subscriber unit (100). If the originating and receiving wireless subscriber units are part of the same digital wireless telephone system (101), the steps of conversion to tones and introduction into the wire based telephone system are omitted, and the call is routed completely within that digital wireless telephone system. In another embodiment of the invention, the step of conversion to tones is entirely omitted and the vocoded data is passed between the two digital wireless telephone systems via an all digital connection such as an ATM packet network (104) or a wire based telephone connection (108) where the integrity of digital information is assured. When a conference call is initiated by one of the wireless subscriber units (100) involved in the telephone call, data from both wireless subscriber units (100) is decoded and placed into analog format so that it can be summed. Additionally, signal processing resources (210) are allocated for the call if the two original wireless subscriber units where part of the same part of the same digital wireless telephone system (101). When the call waiting feature is activated by a wireless subscriber unit (100) involved in a phone call with another wireless subscriber unit (100) additional signal processing resources are also allocated for both the incoming and outgoing data associated with the second call so that is may be properly processed.



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METHOD AND SYSTEM FOR PROCESSING TELEPHONE CALLS INVOLVING TWO DIGITAL WIRELESS SUBSCRIBER UNITS THAT AVOIDS DOUBLE VOCODING

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to digital communications. More particularly, the present invention relates to a novel and improved method and system for interfacing a digital telephone system with a standard public switched telephone network that avoids double vocoding.

II. Description of the Related Art

Digital wireless telephone systems provide telephone service via the use radio of frequency (RF) signals and digital signal processing techniques. The use of RF signals provides the advantage of mobility over traditional wire based telephone systems, and reduces the amount of infrastructure necessary to implement the telephone system. The use of digital signal processing techniques allows telephone calls to be transmitted more efficiently and thereby allows digital wireless telephone systems to carry greater numbers of telephone calls over a given amount of RF bandwidth when compared to a non-digital wireless telephone systems. Maximizing the efficiency with which a wireless telephone system utilizes RF bandwidth is desirable because the amount of RF bandwidth available is a limiting factor as to the number of telephone calls the particular wireless telephone system can carry.

One of the most common types of digital signal processing techniques utilized within a digital wireless telephone systems is vocoding. Vocoding incorporates the use of selective data elimination and data compression to convert a first digital representation of audio information, usually generated by sampling, into a second digital representation that requires less data. Selective data elimination is the act of eliminating some of the information encoded by the data in a way the still allows a comprehensible version of the original audio information to be generated. By eliminating data, and compressing the data which remains, vocoding substantially reduces the amount of digital data that must be transmitted across the RF interface of the wireless telephone system for a telephone call and thereby increases the total number of calls that the wireless telephone systems can carry.

In general, the data associated with a telephone call involving a digital wireless telephone system is introduced into a wire based telephone system for routing to the receiving subscriber unit which is usually part of a wire based telephone system. Wire based telephone systems have traditionally performed the routing function and generally store the information necessary to complete each telephone call. Before being introduced into the wire based telephone system, however, the vocoded data from the digital wireless telephone system must be devocoded using signal processing resources within the digital wireless telephone system. This is because wire based telephone systems generally lack the resources necessary for devocoding the data so that it can be understood by the end user. Once introduced into the wire based telephone system the devocoded data is routed to the receiving subscriber unit.

If the receiving subscriber unit is also part of a digital wireless telephone system, referred to herein as a "wireless subscriber unit," the devocoded data is routed into the associated digital wireless telephone system. Upon being introduced into the digital wireless telephone system the devocoded data is revocoded so that it may be processed further by the digital wireless telephone system. Because selective data elimination causes some audio information to be lost, however, vocoding audio information that has previously been vocoded and devocoded substantially degrades the quality of the audio information that is ultimately produced. Therefore, this present system of routing telephone calls between two wireless subscriber units causes undesirable degradation of audio information. While this "double vocoding" is presently a limited problem because the majority of telephone calls involve at least one wire based subscriber unit, the number of digital wireless subscribers to digital wireless subscriber telephone calls is steadily increasing as the availability of wireless telephone service also increases. Therefore, there is a need for an improved method and system for processing telephone calls where both the initiating and receiving subscribers are part of a wireless telephone system.

Various other changes in telecommunications technology, in addition to the increasing availability of wireless telephone service, have also altered the way people use their telephones. Two of the most prevalent examples of such changes are conference calling and call waiting. Conference calling allows multiple subscribers to communicate with each other simultaneously, and requires that outgoing audio information from two or more subscriber units be combined before being supplied to a

receiving subscriber unit. This combining adds additional complexity to the processing of calls involving two or more wireless subscriber units because vocoded data can not readily be combined in this manner. The call waiting feature allows a single subscriber to alternately communicate with two other subscribers. This can give rise to the situation where a wireless subscriber must interface with both another wireless subscriber and a wire based subscriber further complicating the processing of a wireless subscriber to a wireless subscriber call. These features are very popular services with telephone service subscribers, however, and are a substantial source of revenue for telephone service providers. Therefore, it is desirable to have any improved system and method for processing telephone calls involving two or more wireless subscriber units also accommodate the use of conference calling and call waiting.

SUMMARY OF THE INVENTION

Based on the forgoing, a method and system for processing telephone calls within a digital wireless telephone system is described. During the initiation of a telephone call from a wireless subscriber unit it is determined whether the receiving subscriber unit is also part of a digital wireless telephone system that has compatible vocoding capability. If so, vocoded data from the digital wireless telephone system is converted into tones that are introduced into a wire based telephone system for routing to the appropriate receiving digital wireless telephone system. When these tones are received by the receiving digital wireless telephone system the vocoded data is regenerated based on the tones and then transmitted to the receiving subscriber unit. If the originating and receiving wireless subscriber units are part of the same digital wireless telephone system, the steps of conversion to tones and introduction into the wire based telephone system are omitted, and the call is routed completely within that digital wireless telephone system. In another embodiment of the invention, the step of conversion to tones is entirely omitted and the vocoded data is passed between the two digital wireless telephone systems via an all digital connection such as an ATM packet network or a wire based telephone connection where the integrity of digital information is assured.

When a conference call is initiated by one of the wireless subscriber units involved in the telephone call, data from both wireless subscriber units is devocoded and placed into analog format so that it can be summed. Additionally, signal processing resources are allocated for the call if the two

original wireless subscriber units where part of the same part of the same digital wireless telephone system. When the call waiting feature is activated by a wireless subscriber unit involved in a phone call with another wireless subscriber unit additional signal processing resources are also allocated for both the incoming and outgoing data associated with the second call so that it may be properly processed.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

Figure 1 is a block diagram of a telecommunications network configured in accordance with one embodiment of the invention.

Figure 2 is a digital wireless telephone system configured in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description of a method and system for processing telephone calls within a digital wireless telephone system, various references are made to processes and steps that are performed via the use of "commands," "instructions," and "requests." It should be understood that such references do not describe human actions or thought, but are directed towards the operation, modification and transformation of various systems including and especially those systems which process electrical, electromagnetic, and magnetic signals or charges, along with optical signals or a combination thereof. Fundamental to such systems is the use of various information storage devices, often referred to as "memory," which store information via the placement and organization of atomic, sub-atomic and super-atomic particles on hard disk media, tape, or within silicon, gallium arcinide, or other semiconductor based integrated circuits, and the use of various information processing devices, often referred to as "microprocessors," which alter their condition and state in response to such electrical and electromagnetic signals and charges. Memory and microprocessors that store and process light energy or particles having special optical characteristics, or a combination thereof, are also

contemplated and their use is consistent with the operation of the described invention.

Additionally, various protocols and system configurations are described in detail throughout the application including the use of a code division multiple access (CDMA) cellular telephone system. This is done for purposes of illustration and example, and should not be construed as limiting the scope of the invention. Those skilled in the art will understand that the invention can be used within the context of other digital systems and networks as well. Also, various other well known systems and configurations are described throughout the application in block form. This is done in order to avoid unnecessarily obscuring the disclosure of the present invention.

FIG. 1 is a block diagram of a telephone network configured in accordance with one embodiment of the invention. Asynchronous transfer mode (ATM) service **104** is coupled between wireless telephone system **101(a)** and wireless telephone system **101(b)**, and long distance telecommunications carrier **108** is coupled between local public switch telephone network (PSTN) **102(a)** and local PSTN **102(b)**. Wireless subscriber units **100(a)** and **(b)** are coupled to digital wireless telephone system **101(a)** via first and second radio frequency signal links (RF links) respectively, and wireless subscriber units **100(c)** and **(d)** are coupled to digital wireless telephone system. **101(b)** via third and fourth RF links respectively. In the preferred embodiment these RF links operate in accordance with code division multiple access (CDMA) spread spectrum protocols for improved efficiency and reliability. Local PSTN **102(a)** is coupled to wireless telephone system **101(a)** and wire based subscriber unit **106(a)** and local PSTN **102(b)** is coupled to wireless telephone system **101(b)** and wire based subscriber unit **106(b)**. In alternative embodiments of the invention ATM service **104** may also be coupled to either of local PSTN's **102(a)** or **(b)**, or both, and long distance telecommunications carrier **108** may be coupled to either digital wireless telephone systems **101(a)** or **(b)**, or both.

In an exemplary call initiated by wireless subscriber unit **100(a)**, call request information including a telephone number is transmitted to digital wireless telephone system **100(a)**. Based on this call request information digital wireless telephone system determines the type of a subscriber unit and associated telephone system to which the call is directed. If the call is directed to wire based subscriber unit **106** such as wire based subscriber unit **106(a)**, the call request is forwarded to local PSTN **102(a)** and a connection is

created between wireless subscriber unit **101(a)** and wire based subscriber unit **106(a)**. Vocoded data is then transmitted from wireless subscriber unit **101(a)** over the first RF link to digital wireless telephone system **101(a)**. Digital wireless telephone system **100(a)** responds by devocoding the data and passing pulse code modulated (PCM) data to local PSTN **102(a)** which forwards the PCM data to wire based subscriber unit **106(a)**. On the return path, PCM formatted data from wire based subscriber unit **106(a)** passes through local PSTN **102(a)** to digital wireless telephone system **101(a)**. Digital wireless telephone system **101(a)** converts the PCM formatted data to vocoded data and transmits the vocoded data via the first RF link to wireless subscriber unit **100(a)**. Wireless subscriber unit **100(a)** proceeds to devocode the vocoded data to generate audio information.

If wireless telephone system **101(a)** determines that the telephone call from wireless subscriber unit **100(a)** is directed to wireless subscriber unit **100(b)**, the route through which the data associated with the telephone call is different than that of the telephone call between wireless subscriber unit **100(a)** and wire based subscriber unit **106(a)**. After digital wireless telephone system **101(a)** receives the vocoded data from subscriber **100(a)** via the first RF link, digital wireless telephone system **101(a)** proceeds to transmit that vocoded data to wireless subscriber unit **100(b)** through the second RF link. Wireless subscriber unit **100(b)** then devocodes the data to generate comprehensible audio formation. On the reverse path, vocoded data from wireless subscriber unit **100(b)** is received by wireless telephone system **101(a)** via the second RF interface, and then passed to wireless subscriber unit **100(a)** via the first RF interface. Wireless subscriber unit **100(a)** then also devocodes the vocoded data to generate comprehensible audio information. Thus, the call is routed completely within digital wireless telephone system **101(a)**, and the audio information is only vocoded a single time in either direction.

If wireless telephone system **101(a)** determines that the telephone call from wireless subscriber unit **100** is directed to a wireless subscriber unit that is part of, or interfacing with, a different digital wireless telephone system such as wireless subscriber unit **100(c)**, vocoded data received via the first RF interface is converted into tones by wireless telephone system **101(a)**. In the preferred embodiment, this is done in a manner similar to that of a conventional computer modem device that allows digital systems such as computers to communicate and transmit digital information over standard analog telephone lines. These tones are further converted by digital wireless

system 101(a) into PCM format and the PCM formatted tones are introduced into local PSTN 102(a). The PCM formatted tones pass through long distance telecommunication carrier 108 and local PSTN 102(b) to digital wireless telephone system 101(b). Digital wireless telephone system 101(b) demodulates the tones to generate an exact or near exact binary copy of the original vocoded data transmitted, the process for which is well known in the art. This vocoded data is then transmitted to wireless subscriber unit 100(c) via the third RF interface where the vocoded data is devocoded in order to produce audio information. Vocoded data on the return path is similarly converted to tones for transmission over local PSTN's 102(a) and (b) and long distance telecommunications carrier 108.

In two alternative embodiments of the invention, the step of converting the vocoded data into tones for transmission to the receiving wireless telephone system is omitted. In the first alternative embodiment, the conversion step is omitted by establishing a long distance link which ensures an all digital connection between digital wireless telephone system 101(a) and digital wireless telephone system 101(b). In the preferred embodiment, the request for such a link is made during the initial setup of the telephone call, various methods for which are known in the art including out of band and digital message signaling. In the second alternative embodiment, the vocoded data can be exchanged between digital wireless telephone system 101(a) and digital wireless telephone system 101(b) via ATM service 104. ATM service 104 provides a digital packet based link that substantially ensures the integrity of the digital data transmitted and therefore provides an ideal mechanism for exchanging the vocoded data. However, the present availability of such ATM service is limited.

Once a telephone call between two wireless subscriber units is established, digital wireless telephone system 101(a) monitors wireless subscriber unit 100(a) for requests to initiate a conference call. If such a request is received, the processing of the telephone call is altered. If the telephone call is with a wireless subscriber unit 100 that is part of a different digital wireless telephone system 101, the vocoded data from each wireless subscriber unit. 100 is converted into analog data format within the two digital wireless telephone systems 101, instead of into PCM formatted tones. The analog data from the two wireless subscriber units 100 is then combined within digital wireless telephone system 101(a). If the call is between two wireless subscriber units 100 that are part of the digital wireless telephone system 100(a), the vocoded data from each wireless subscriber unit 100 is

converted into analog format and combined within digital wireless telephone system **100(a)**. Once the data is combined, the summed data is revocoded and transmitted back to each of the wireless subscriber units. This causes double vocoding, but allows wireless telephone system **101(a)** to provide the feature of conference calling to its subscribers.

To provide the call waiting feature during a telephone call between wireless subscriber unit **100(a)** and another wireless subscriber unit **100**, digital wireless telephone system **101(a)** monitors for incoming telephone call requests directed to wireless subscriber unit **100(a)**. If the call request is from a wire based subscriber unit **106**, additional signal processing resources are allocated within digital wireless telephone system **101(a)** to convert the data associated with the second telephone call between vocoded and PCM format. If the call request is from a wireless subscriber unit **100** the call is handled in accordance with a call to another wireless subscriber unit **100** as described above. Once the second call has been established wire telephone system **101(a)** switches between the two calls in accordance with the standard operation of call waiting.

FIG. 2 is a block diagram of a digital wireless telephone system **101(a)** configured as a cellular telephone system interfacing with wireless subscriber units **100(a)** and **(b)** of **FIG. 1** as well as wireless subscriber units **100(e)** and **(f)** in accordance with one embodiment of the invention. Base transceiver stations (BTS) **200(a)** and **(b)** interface with subscriber units **100(a)**, **(b)**, (c) and (f) via first, second, fifth and sixth RF links respectively and are coupled to CDMA interconnect subsystem (CIS) **202** located within base station controller **204** via hardwire connection or microwave link. CIS **202** is coupled to selector element bank **204**, call control processor (CCP) **206**, and ATM network interface **208**. CCP **206** is coupled to home location register (HLR) **207** and PSTN interface **212**. Service options element **210** is coupled to selector element bank **204** and PSTN interface **212**, which is coupled to local PSTN **102(a)** of **FIG. 1**. ATM network interface **208** is coupled to an ATM service **104** of **FIG. 1**. During operation the various systems communicate using control packets exchanged via the connections shown, and which are routed by CIS **202** via the use of an address contained in each packet. The connections shown also carry traffic data via packets with the type of data contained in a packet being indicated by header bits also contained in each packet.

In an exemplary telephone call, a request to initiate the telephone call including a telephone number from wireless subscriber unit **100(a)** is

transmitted through the first RF link to BTS **200(a)** and CIS **202** to call control processor **206**. Call control processor **206** determines based on the telephone number whether the telephone call is directed to another wireless subscriber unit **100** and whether that wireless subscriber unit **100** is part of the same wireless telephone system as the originating wireless subscriber unit **100**. In the preferred embodiment these determinations are made using HLR **207** which is data base stored within a memory system. The HLR stores and tracks the telephone numbers and other associated information of subscribers to the wireless telephone service, and may be located within base station controller **204** as shown, or at a remote location coupled to CCP **206** via high speed network connection. CCP **206** may also make this determination by generating an information request message, preferably during the call set up, directed to the receiving telephone system to indicate what type of system it is, and the telephone system's signal processing capabilities. This second method of determining is preferred where the receiving telephone system is not part of the same wireless telephone service provider.

If CCP **206** determines that the receiving subscriber unit is also part of digital wireless telephone system **101(a)** it configures selector element bank **204** to route any information received associated with the call back to CIS **202**. Selector element bank **204** performs the function of selecting between two or more instances of data generated when a wireless subscriber unit **100** is in soft hand-off, the preferred operation for which is described in U.S. Patent No. 5,101,501 entitled "METHOD AND SYSTEM FOR PROVIDING SOFT HANDOFF IN COMMUNICATIONS IN A CDMA CELLULAR COMMUNICATION SYSTEM" and U.S. Patent No. 5,267,261 entitled "MOBILE ASSISTED SOFT HANDOFF IN A CDMA CELLULAR COMMUNICATIONS SYSTEM," both assigned to the assignee of the present invention. Also, CCP **206** configures the selector resource to direct any information received to wireless subscriber unit **100(a)** via CIS **202**. If the wireless subscriber unit **100(a)** is in soft handoff the selector element resource generates multiple copies of the data being transmitted and direct one copy to each base transceiver station **200** that has established a RF link with wireless subscriber unit **100(a)**. The data is directed by placing the appropriate address with packets in which the data is transmitted, with the appropriate address being supplied to the selector resource by CCP **206**. In the preferred embodiments of the invention a selector resource is comprised of a microprocessor configured via the use of a set of software instructions

stored in a hard-disk or integrated circuit memory or both. Similarly, a second selector resource is allocated for the receiving subscriber unit and vocoded data from the second selector resource is direct back to CIS 202 which passes the vocoded data to wireless subscriber unit 101(a). The number of selector resources that can be provided by a particular microprocessor is determined by the processing power of that microprocessor. In the preferred embodiment of the invention CCP 202 is comprised of a hard-disk or integrated circuit based memory containing instructions and a microprocessor to for receiving those instructions and generating commands and in response.

If CCP 206 determines that the call from wireless subscriber unit 100(a) is not directed to another wireless subscriber unit, but is directed to a wire based subscriber unit 106, such as wire based subscriber unit 106(a) of FIG. 1, it allocates and configures a selector resource within selector element bank 204 to forward vocoded data from wireless subscriber unit 100(a) to service options element 210. Service options element 210 is configured by CCP 206 to devocode the vocoded data and to place the devocoded data into PCM format. The PCM formatted data is passed into PSTN interface 212 which introduces the PCM formatted data into local PSTN 102(a) (FIG. 1). PSTN 102(a) routes the data to wire based subscriber unit 106(a). On the reverse path, PCM formatted data from the wire based subscribed unit 106 received through PSTN interface 212 is placed into vocoded format by service options element 210 and then routed to wireless subscriber unit 100(a).

If CCP 206 determines that the call request from wireless subscriber unit 100(a) is directed to a wireless subscriber unit 100 that is part of a different wireless telephone system, such as a digital wireless telephone system 101(c) (FIG. 1), it configures selector element bank 204 to route vocoded data from wireless subscriber unit 100(a) to service options element 210. Additionally, CCP 206 configures service options element 210 to convert that vocoded data into tones that are introduced unto PSTN interface 212 which forwards the data to local PSTN 102(a) of FIG. 1. CCP 206 also notifies the receiving wireless telephone system during call setup that the data will be delivered in tone format so that the receiving wireless telephone system may prepare to demodulate the data accordingly.

For calls originating from another wireless subscriber unit directed to one of wireless subscriber unit 100(a), (b), (e) or (f), CCP 206 receives notification of an incoming call via PSTN interface 212. In addition to this notification, CCP 206 receives information indicating that the requesting

subscriber unit is a wireless subscriber unit that incorporates vocoding techniques compatible with those wireless subscriber units **100** and that the data will be transmitted in tones. In response, CCP **206** configures service options element **210** to receive the vocoded data bits transmitted in tone format and to demodulate those tones in order to generate a substantially accurate version of the vocoded data. This vocoded data is passed through selector element bank **204**, CIS **202** and the appropriate BTS **200** to the receiving wireless subscriber unit **100**. The vocoded data is then demodulated by that wireless subscriber unit **100** in order to generate audio information.

In the first alternative embodiment of the invention, upon receiving a call request from wireless subscriber unit **100(a)** directed to another wireless subscriber unit **100** located at a remote wireless telephone system, CCP **206** transmits a request for an all digital link via PSTN interface **212**. If this request is successful, CCP **206** configures service options element **210** to pass the vocoded data into PSTN interface **212** where it is introduced into a local PSTN **102(a)** **(FIG. 1)**. Additionally, CCP **206** signals the receiving digital wireless telephone system **101** during the call setup to receive unmodulated vocoded data. Furthermore, if a message is received by CCP **206** indicating an incoming call is arriving via an all digital network, CCP **206** configures service option element **210** to pass the vocoded data onto selector element bank **204** for routing to the receiving digital wireless subscriber unit **100**.

In the second alternative embodiment of the invention, upon determining that a call request from wireless subscriber unit **100(a)** is directed to another wireless subscriber unit **100** (not shown) that is part of a different wireless telephone system **101** (also not shown) having compatible vocoding capability, CCP **206** configures a selector resource within selector element bank **204** to route information associated with that call back to ATM network interface **208** via CIS **202**. ATM network interface **208** passes the data onto ATM service **104** of **(FIG. 1)**, which in turn routes the information to the other wireless subscriber unit **100** to which the call is directed. Incoming requests to communicate received via ATM network interface **208** cause CCP **206** to allocate a selector resource within selector element bank to processed the telephone call, and to configure ATM network interface **208** and CIS **202** to direct the incoming vocoded data directly to the selector element resource. The selector element then makes additional copies of the data as needed and routes each copy of the data to the receiving wireless subscriber unit **100**.

Once a telephone call between wireless subscriber unit **100(a)** and another wireless subscriber unit **100** has been established, CCP **206** monitors for conference call requests direct to wireless subscriber unit **100(a)** and takes various actions in response to such a request depending on whether the second wireless subscriber unit is part of wireless telephone system **101(a)**, for example wireless subscriber unit **100(b)**. If so, CCP **206** responds by configuring the selector resources assigned to each of wireless subscriber units **100(a)** and **100(b)** to direct vocoded data to service options element **210**. CCP **206** also configures service options element **210** to devocode the vocoded data from wireless subscriber units **100(a)** and **(b)**, and to pass the unvocoded data to PSTN interface **212**. Additionally, CCP **206** configures PSTN interface **212**, which contains the necessary multiplexing circuitry, to combine the unvocoded data from wireless subscriber units **100(a)** and **(b)**, as well as from the third subscriber unit that is entering into the conference call. This third subscriber unit may either be a wireless or a wirebased subscriber unit. The combined data is then directed back to each subscriber unit engaged in the conference call by PSTN interface **212**. For each wireless subscriber unit **100** engaged in the conference call and that is part of the same wireless telephone system, the combined data is transmitted through service options element **210**, where it is vocoded, and then routed through the corresponding selector resource to the intended wireless subscriber unit **100**. For a wireless subscriber unit **100** that is part of different digital wireless telephone systems, or for wire based subscriber units **106**, the combined data is introduced into local PSTN **104(a)** in unvocoded form.

To provide call waiting during a telephone call between wireless subscriber unit **100(a)** and another wireless subscriber unit **100** CCP **206** monitors for incoming calls directed to wireless subscriber system **100(a)**. When such a call is received, CCP **206** notifies the user of wireless subscriber unit **100(a)** by generating a vocoded beep or tone, or other type of digital indication message that is routed to the selector resource associated with wireless subscriber unit **100(a)**. The selector resource then generates copies of the message depending on whether wireless subscriber unit **100(a)** is engaged in soft handoff, and routes each copy via CIS **202** to any base transceiver stations **200** engaged in an RF link with wireless subscriber unit **100(a)**. Each base transceiver station **200** then transmits the message to wireless subscriber unit **100(a)**. If the incoming call is accepted, CCP **206** configures the interface system receiving the data from the second call, which in the embodiment shown is either PSTN interface **212** or ATM

network interface 208, to route the data from the second call to the selector resource processing the call. CCP 206 also configures the selector resource to forward the data associated with the second call to wireless subscriber unit 100(a) in normal fashion. Data from the first call is ignored by the selector resource during this time. As wireless subscriber unit 100(a) then switches between the first phone call and the second phone call in accordance with the standard operation of the call waiting feature, CCP 206 configures the selector resource to forward the incoming data associated with the first or second call accordingly, and to direct the data received from wireless subscriber unit 100(a) to the subscriber unit associated with the call that is currently active via the corresponding interface system. Indication that the call is accepted, and switching between the two telephone calls, is performed via the use of a "flash" or other feature key located on the receiving wireless subscriber unit 100.

To properly process and switch between the first and second calls during call waiting, CCP determines whether the second call is from a wireless subscriber unit 100 that is part of the same wireless telephone system 101, or if the second call is from either a wire base subscriber unit 106 or wireless subscriber unit 100 that is part of a different wireless telephone system. In the preferred embodiment, this determination is done in the same manner as the determinations made during call set up. If the second call is from a wireless subscriber unit 100 that is part of the same system, CCP 202 allocates a selector resource within selector element bank to perform the selection function for that wireless subscriber unit 100 and routes the call back through CIS 202 to the receiving subscriber unit 100 if the call is accepted. If the second call is from a wire based subscriber unit 106, or a wireless subscriber unit 100 that is part of a different wireless telephone system, CCP 202 configures service options element 206 to process the data from the incoming telephone call by converting the incoming tones or PCM formatted data into vocoded data as described above. If call is accepted the vocoded data is routed to the receiving wireless subscriber unit 100.

Thus, a method and system for processing a telephone call between two wireless subscriber units that prevents double vocoding, and that provides the desirable features of conference calling and call waiting, is described. Additionally, the invention provides such functionality while also allowing soft handoff capability to be maintained within a cellular telephone system, which is also highly desirable. While the invention is set forth in the context of a digital wireless telephone system in general and a

cellular telephone system in particular, other uses and embodiments of the invention including satellite based telecommunication systems will be apparent to one skilled in the art. The exemplary embodiment provided is merely for purposes of illustration and should not be construed as limiting the scope of the invention.

I (WE) CLAIM:

CLAIMS

1. A method for processing a telephone call from a wireless subscriber unit that is part of a wireless telephone system comprising the steps of:

(a) receiving a request to make said telephone call to a receiving subscriber unit;

(b) devocoding vocoded data from said wireless subscriber unit if said receiving subscriber unit is a wire based subscriber unit;and

(c) delivering said vocoded data to said receiving subscriber unit if said receiving subscriber unit is a wireless subscriber unit.

2. The method as set forth in claim 1 wherein step (c) is comprised of the steps of:

(c.1) routing said vocoded data to said receiving subscriber unit within said wireless telephone system if said receiving subscriber unit is part of said wireless telephone system; and

(c.2) routing said vocoded data through a long distance telecommunications system if said receiving subscriber unit is part of a second wireless telephone system.

3. The method as set forth in claim 2 wherein step (c.2) is comprised of the step of converting said vocoded data into tones.

4. The method as set forth in claim 3 wherein step (c.2) is further comprised of the step of signaling to said second wireless system that said vocoded data will be transmitted in tones.

5. The method as set forth in claim 2 wherein step (c.2) is comprised of the steps of:

establishing an all digital link to said second wireless telephone system; and

delivering said vocoded data to said second wireless system over said all digital link.

6. The method as set forth in claim 5 wherein said all digital link is an ATM network.

7. The method as set forth in claim 5 wherein said all digital link passes through a local public switched telephone network, and a long distance telecommunications system.

8. The method as set forth in claim 1 further comprising the steps of:

receiving a conference call request from said wireless subscriber unit directed to a third subscriber unit;

converting said vocoded data from said wireless subscriber unit into combinable data;

generating combined data by combining said combinable data and data from said third subscriber unit; and

generating combined vocoded data by vocoding said combined data and transmitting said combined vocoded data to said receiving subscriber unit.

9 The method as set forth in claim 8 wherein said combinable data is pulse code modulated data.

10. The method as set forth in claim 1 further comprising the steps of:

detecting an incoming call to said wireless subscriber unit from third subscriber unit;

allocating signal processing resources to place data from said third subscriber unit into vocoded format if said third subscriber unit is part of another telephone system; and

transmitting said data from said third subscriber unit to said wireless subscriber unit when call waiting is activated.

11. A cellular telephone system for processing a telephone call from a requesting subscriber unit that is part of a wireless telephone system directed to a receiving subscriber unit comprising:

signal routing circuitry;

signal processing circuitry for processing vocoded data;

a call control processor coupled to said signal processing circuitry and said signal routing circuitry, for configuring said signal routing circuitry to bypass said signal processing circuitry if said receiving subscriber unit is part of said cellular telephone system, and for configuring said signal processing circuitry to devocode said vocoded data if said receiving subscriber unit is wire based.

12. The cellular telephone system of claims 11 wherein said call control processor configures said signal routing circuitry to route said vocoded data to said receiving subscriber unit within said cellular telephone system if said receiving subscriber unit is part of said wireless subscriber system, and to route said vocoded data through a long distance telecommunication service is said receiving subscriber unit is part of a second wireless telephone system.

13. The cellular telephone system as set forth in claim 11 where said signal routing circuitry further comprises an interconnect subsystem.

14. The cellular telephone system as set forth in claim 11 wherein said call control processor configures said signal processing circuitry to convert said vocoded data into tones if said receiving subscriber unit is part of a second wireless telephone system, and configures said signal routing circuitry to deliver said tones to a long distance telecommunications carrier.

15. The cellular telephone system as set forth in claim 12 wherein said call control processor requests an all digital connection to said receiving subscriber unit if said receiving subscriber unit is part of a second wireless telephone system, and configures said signal routing circuitry to deliver said vocoded data to said receiving subscriber unit through said all digital connection.

16. The cellular telephone system as set forth in claim 12 wherein said all digital connection passes through a local public switched telephone network and a long distance telecommunications system.

17. The cellular telephone system as set forth in claim 12 wherein said all digital connection is an asynchronous transfer mode network.

18. The cellular telephone system as set forth in claim 11 wherein:

said call control processor receives a conference call request from said wireless subscriber unit directed to a third subscriber unit, and configures said signal processing circuitry to convert said vocoded data from said wireless subscriber unit into combinable data, to generate combined data by combining said combinable data and data from said third subscriber unit, and to generate combined vocoded data by vocoding said combined data and transmitting said combined vocoded data to said receiving subscriber unit.

19. The cellular telephone systems as set forth in claim 19 wherein said combinable data is pulse code modulated data.

20. The cellular telephone system as set forth in claim 11 wherein:

said call control processor detects an incoming call to said wireless subscriber unit from third subscriber unit and configures said signal processing resources to place data from said third subscriber unit into vocoded format if said third subscriber unit is part of another telephone system if call waiting is activated.

21. A wireless telephone system for processing a telephone call from a requesting subscriber unit that is part of a wireless telephone system directed to a receiving subscriber unit comprising:

means for routing digital information;

means for processing vocoded data;

means for configuring said means for routing to bypass said means for processing if said receiving subscriber unit is part of said wireless telephone system, and for configuring said means for processing to devocode said vocoded data if said receiving subscriber unit is wire based, said means for configuring being coupled to said means for processing and said means for routing.

22. The wireless telephone system of claims 21 wherein said means for configuring configures said means for routing to route said vocoded data

to said receiving subscriber unit within said wireless telephone system if said receiving subscriber unit is part of said wireless subscriber system, and to route said vocoded data through a long distance telecommunication service if said receiving subscriber unit is part of a second wireless telephone system.

23. The wireless telephone system as set forth in claim 22 where said means for routing comprises an interconnect subsystem;

24. The wireless telephone system as set forth in claim 23 wherein said means for configuring configures said means for processing to convert said vocoded data into tones, and configures said means for routing to delivery said signal to a long distance telecommunications carrier, if said receiving subscriber unit is part of a second wireless telephone system.

25. The wireless telephone system as set forth in claim 24 wherein said means for configuring requests an all digital connection to said receiving subscriber unit if said receiving subscriber unit is part of a second wireless telephone system, and configures said means for routing to deliver said vocoded data to said receiving subscriber unit through said all digital connection if said al digital connection is supplied.

26. The wireless telephone system as set forth in claim 25 wherein said all digital connection passes through a local public switched telephone network and a long distance telecommunications system.

27. The wireless telephone system as set forth in claim 26 wherein said all digital connection is an asynchronous transfer mode network.

28. The wireless telephone system as set forth in claim 21 wherein:
said means for controlling receives a conference call request from said wireless subscriber unit directed to a third subscriber unit, and configures said means for processing to convert said vocoded data from said wireless subscriber unit into combinable data, to generate combined data by combining said combinable data and data from said third subscriber unit,

and to generate combined vocoded data by vocoding said combined data and transmitting said combined vocoded data to said receiving subscriber unit.

29. The wireless telephone systems as set forth in claim 28 wherein said combinable data is pulse code modulated data.

30.. The wireless telephone system as set forth in claim 21 wherein: said means for configuring detects an incoming call to said wireless subscriber unit from third subscriber unit and configures said means for processing to place data from said third subscriber unit into vocoded format if said third subscriber unit is part of another telephone system.

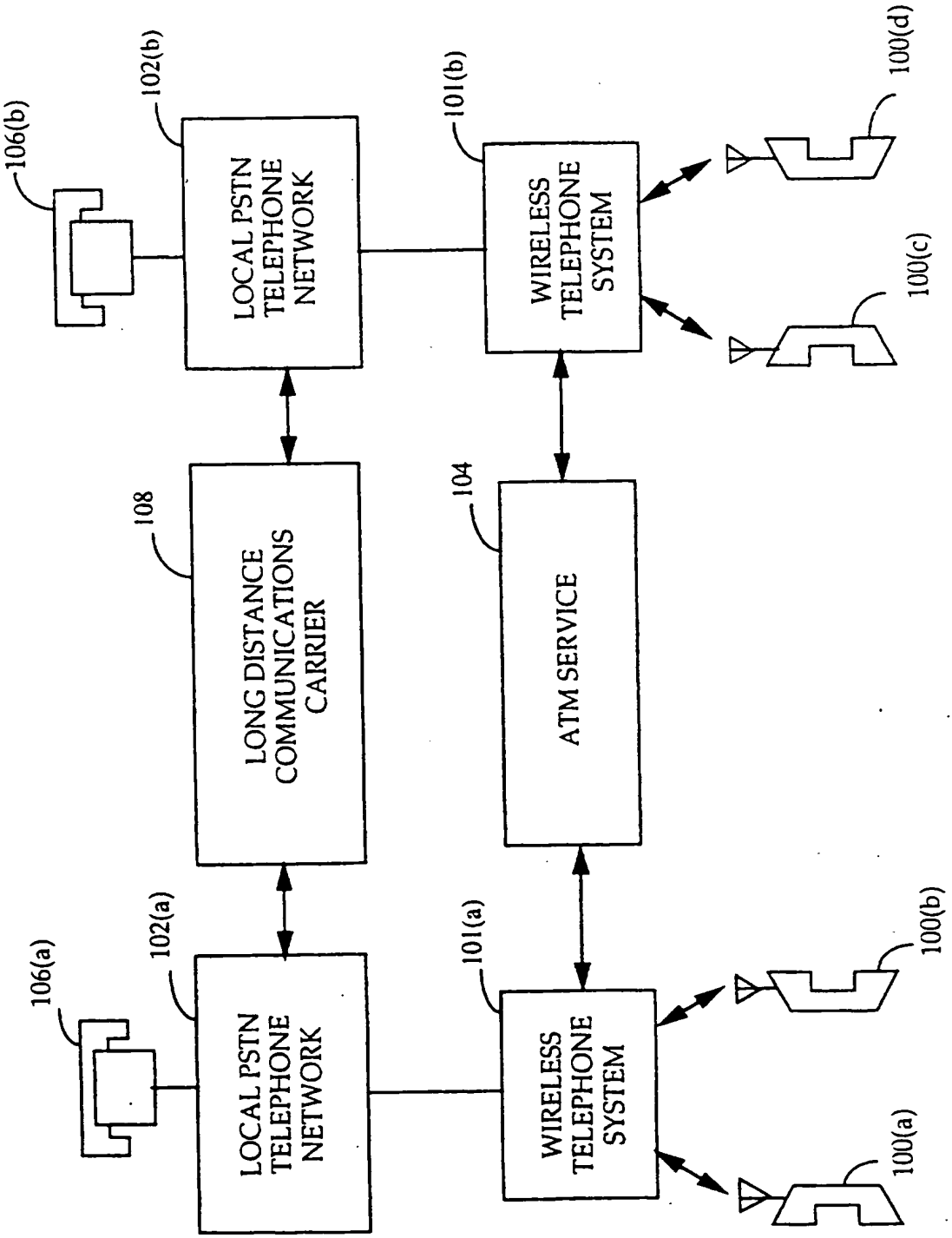
LOCAL PSTN TELEPHONE NETWORK
LOCAL PSTN TELEPHONE NETWORK
LONG DISTANCE COMMUNICATIONS CARRIER
WIRELESS TELEPHONE SYSTEM
WIRELESS TELEPHONE SYSTEM
ATM SERVICE
102(b)
102(a)
108
101(b)
101(a)
104
106(b)
106(a)
100(d)
100(c)
100(b)
100(a)

FIG. 1

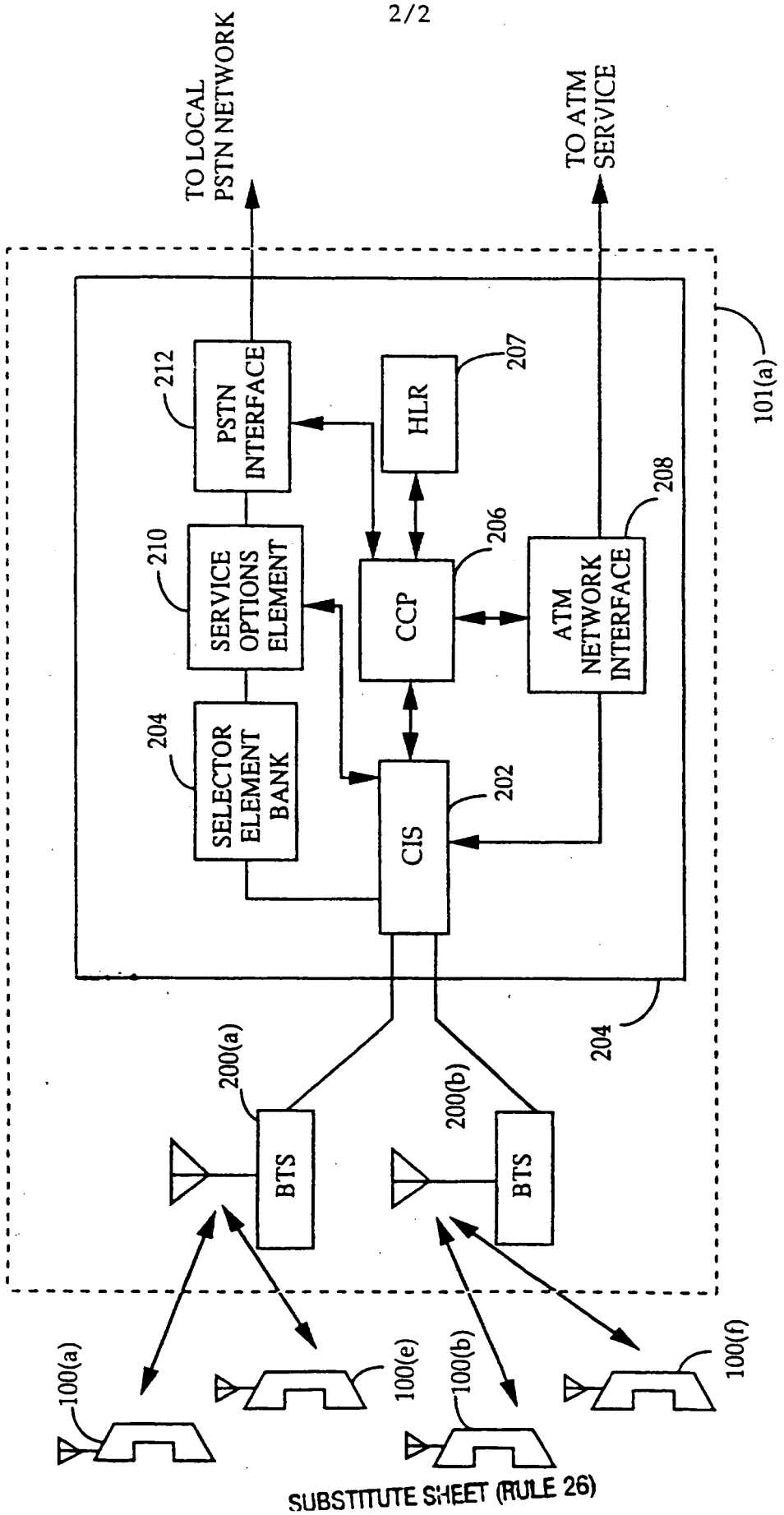

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/15695

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38 H04Q7/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 664 658 A (AT & T CORP) 26 July 1995 see column 4, line 25 - line 57 see column 6, line 48 - column 7, line 20 see column 7, line 49 - column 8, line 13 see column 7, line 20 - line 58 ---	1,2,5-7, 11,12, 15-17, 21,22
X	EP 0 605 311 A (ALCATEL RADIOTELEPHONE) 6 July 1994 see column 2, line 28 - column 3, line 13 see column 3, line 27 - line 39 see column 5, line 38 - column 6, line 11 see column 6, line 40 - line 47 --- -/--	1,11,21

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 January 1997	14. 02. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Gerling, J.C.J.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/15695

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 95 15665 A (MOTOROLA INC) 8 June 1995 see claims 1,8,10	1,11,21
E	WO 96 42176 A (QUALCOMM INC) 27 December 1996 see page 3, line 9 - line 25 see page 4, line 31 - page 5, line 6 see page 5, line 35 - page 6, line 37 see page 7, line 33 - page 9, line 10	1,2,5,6, 11,12, 15,17, 21,22

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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